

# PATENT ABSTRACTS OF JAPAN

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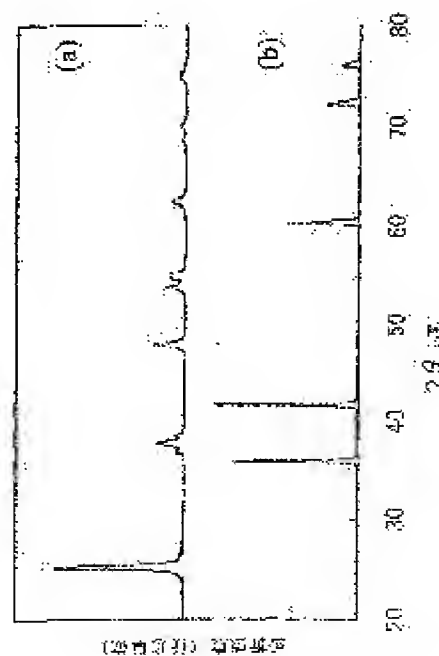
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## (54) HIGHLY ACTIVE PHOTOCATALYST CARBON-DOPED TITANIUM DIOXIDE AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a photocatalyst material comprising TiO<sub>2</sub> doped with carbon which has not been manufactured, and its manufacturing method.

SOLUTION: The photocatalyst material comprising highly active photocatalyst carbon-doped titanium dioxide is manufactured by calcining titanium carbide in air or oxygen atmosphere. The photocatalyst material comprising anatase type or rutile type titanium dioxide is manufactured from titanium carbide by the calcination condition of titanium carbide.



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## CLAIMS

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[Claim(s)]

[Claim 1]

A photocatalyst material which consists of a hyperactive photocatalyst carbon dope titanium dioxide obtained by doping carbon to a titanium dioxide.

[Claim 2]

A manufacturing method of a photocatalyst material which consists of a hyperactive photocatalyst carbon dope titanium dioxide by calcinating titanium carbide in air or oxygen environment.

[Claim 3]

A method according to claim 2 by which a photocatalyst material which consists of a carbon dope titanium dioxide of an anatase type or a rutile type is produced from titanium carbide by firing condition of titanium carbide.

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[Translation done.]

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to a carbon dope  $\text{TiO}_2$  photocatalyst material and its manufacturing method. It is related with the photocatalyst material obtained in more detail by calcinating  $\text{TiC}$  at an elevated temperature in air or oxygen environment, and its manufacturing method.

[0002]

[Description of the Prior Art]

The use on the art as a photocatalyst material with various  $\text{TiO}_2$  from the former has been tried. Research which dopes an impurity to the compound even now for the purpose of raising photocatalyst performance is done briskly.

[0003]

Attentions have gathered for the nonmetallic dope to  $\text{TiO}_2$  in the latest research. By JP,2001-205103,A, by doping nitrogen, the light absorption band of  $\text{TiO}_2$  is expanded from an ultraviolet area to a visible range, and is reported to have succeeded in the development of material which has photocatalyst performance also under visible light as a result. The same effect is acquired also when sulfur is doped (application for patent 2002-161069). In fluoride dope  $\text{TiO}_2$ , while an optical response improves, it is said that photocatalyst performance improves. Thus, having the work which raises the photocatalyst performance of the substance concerned is shown, and the nonmetallic dope to  $\text{TiO}_2$  can expect the same effect also to the nonmetallic element C. However, C dope The example that  $\text{TiO}_2$  was produced does not exist.

[0004]

[Problem(s) to be Solved by the Invention]

This invention is made based on the above situation, and enables production of carbon dope  $\text{TiO}_2$  without the produced example. The technical problem of this invention is providing carbon dope  $\text{TiO}_2$  and its producing method.

[0005]

[Means for Solving the Problem]

This invention provides a photocatalyst material produced by calcinating TiC as what solves the above-mentioned technical problem, and its producing method. In detail, a manufacturing method which calcinates TiC in air or oxygen environment in the temperature 300 - 800 \*\* is made into the mode.

[0006]

[Embodiment of the Invention]

The photocatalyst material which this invention provides is obtained by calcinating TiC as above-mentioned. There is no restriction in particular in the burning method of TiC in this invention, and it is performed by the electric furnace etc. in air or oxygen environment. Calcination temperature is 300-800 \*\* (preferably around 350 \*\*), and time is 1 - 200 hours (preferably around 100 hours).

[0007]

Powder is preferred although there is no restriction in particular also in the shape of TiC used by this invention. If it is powder, that by which particle diameter was controlled is marketed.

[0008]

[Example]

Hereafter, an example is shown and this invention is explained further in detail.

(Example 1)

TiC powder (particle diameter: 0.9-1.5 micrometers) was heat-treated at 350 \*\* in the air only for 100 hours. X diffraction of the obtained powder crystal and a TiC powder crystal (XRD) A difference of a pattern is shown in drawing 1. (a) of drawing 1 is a XRD measurement result of the powder produced by being 350 \*\* and heat-treating titanium carbide (TiC) for 100 hours, and (b) of drawing 1 is a XRD measurement result of pure TiC. It became clear for TiC to have oxidized and to have changed to anatase type  $\text{TiO}_2$  from the result of XRD.

[0009]

It turned out that 2 to 3 times as much carbon exists in  $\text{TiO}_2$  produced by this invention as compared with pure  $\text{TiO}_2$  by scanning electron microscope (SEM/EDX) measurement equipped with the elemental analysis device. It was shown from the above result that carbon dope anatase  $\text{TiO}_2$  has been produced.

[0010]

The result of a decomposition experiment of the water to carbon dope anatase  $\text{TiO}_2$  and pure anatase  $\text{TiO}_2$  is shown in drawing 2. Each sample (1g) was put into pure water 400 ml, and the decomposition experiment of water was conducted by measuring the quantity of the hydrogen generated during a UV lamp exposure (light source: UV lamp of 300 W) with gas chromatography. From the result of this experiment, it is a carbon dope anatase type. It became clear that  $\text{TiO}_2$  has photocatalyst performance higher than pure undoped  $\text{TiO}_2$ .

[0011]

(a) of drawing 2 shows the generated amount of the hydrogen generated by disassembly of the water to the ultraviolet radiation irradiation time of carbon dope anatase type  $\text{TiO}_2$  produced from calcination of  $\text{TiC}$ , (b) of drawing 2 shows the generated amount of the hydrogen generated by disassembly of the water to the ultraviolet radiation irradiation time of pure anatase type  $\text{TiO}_2$ .

[0012]

(Example 2)

The powder crystal obtained after heat treatment of 2 hours at 800 \*\* in the air in  $\text{TiC}$  powder is XRD. It became clearer than a pattern that it is a rutile titanium dioxide. What production of the same rutile type titanium oxide as a pure titanium dioxide was able to carry out also from the ultimate analysis of the sample following it was checked.

[0013]

[Effect of the Invention]

1. By heat-treating  $\text{TiC}$  in the air, a new optical functional material called carbon dope anatase type  $\text{TiO}_2$  was invented.

[0014]

2. Carbon dope anatase type  $\text{TiO}_2$  has high photocatalyst performance and is more effective as a new hyperactive photocatalyst material per unit weight than as anatase type  $\text{TiO}_2$  for the conventional marketing.

[0015]

3. A rutile type and anatase type titanium oxide were able to be independently produced by the calcination temperature of  $\text{TiC}$ , and change of firing time.

[Brief Description of the Drawings]

[Drawing 1] It is a figure showing the XRD measurement result of the sample (a) after being 350 \*\* and heat-treating titanium carbide ( $\text{TiC}$ ) for 100 hours, and pure  $\text{TiC}$  (b).

[Drawing 2] It is a figure showing the moisture solution experimental result of carbon dope anatase type  $\text{TiO}_2$  (a) produced from calcination of  $\text{TiC}$ , and pure anatase type  $\text{TiO}_2$  (b).

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[Translation done.]